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Coalition Battle Management Language

Andreas Tolk, Ph.D.
Virginia Modeling Analysis & Simulation Center
Old Dominion University
Norfolk, VA 23529
United States
atolk@odu.edu

Major Kevin Galvin
Ministry of Defence,
Directorate of Equipment Capability (Ground Manoeuvre)
Darenth House, 84 Main Road
Sundridge
Sevenoaks, Kent, TN14 6ER
United Kingdom
kgalvin@qinetiq.com

Michael Hieb, Ph.D.
Alion Science & Technology
1901 N. Beauregard St.
Alexandria, VA 22311-1705
United States
Michael.R.Hieb@us.army.mil

Lionel Khimeche
DGA
18 rue du Docteur Zamenhof
Fort d'Issy-les-Moulineaux
Issy-les-Moulineaux cedex, 92131
France
lionel.khimeche@dga.defense.gouv.fr

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ABSTRACT: *Battle Management Language (BML) is being developed as an unambiguous language to command and control forces and equipment conducting military operations and provide for situational awareness and a shared, common operational picture. BML is being designed as a standard representation of a "digitized commander's intent" to be used for real troops, for simulated troops, and for future robotic forces.*

A US Army BML prototype was used in the UK to analyze the applicability of these concepts to UK doctrine. A French Army BML has also been prototypically implemented in France, independently from – but well aware of – the US prototype. A study group on coalition applicability of such concepts has been initiated.

Three views are necessary to describe BML:

(1) A Doctrine View – BML must be aligned to doctrine;

(2) A Representation View – BML must model these aspects in a way that can be interpreted and processed by the underlying heterogeneous information technology systems of the coalition;

(3) A Protocol View – BML must specify the underlying protocols for transferring BML information between the participating systems.

This paper will give an introduction to BML for the study group members, will show the areas already being worked on, and will present the initial scope of the work to be done.

1 Introduction

This paper introduces the fundamental Battle Management Language (BML) concepts to support the initialization of a Simulation Interoperability Standards Organization (SISO) study group. It presents the first results of a literature search. Furthermore, current research on BML topic is summarized and documented.

Generally, BML is the unambiguous language used to

- command and control forces and equipment conducting military operations and,
- provide for situational awareness and a shared, common operational picture.

It can be seen as a standard representation of the "digitized commanders intent" to be used for real troops, for simulated troops, and for future robotic forces. BML is particularly relevant in a network centric environment for enabling mutual understanding.

A prototypical implementation of a BML was developed and demonstrated at the beginning of 2003. While the first prototype was U.S. Army centric, an initiative under the Extensible M&S Framework (XMSF) is currently transforming the BML prototype into a Joint and Coalition solution based on open standards. This second prototype demonstrates a Web enabled or Extensible Battle Management Language (XBML) "extended" by applying the concepts of the XMSF. In addition, air operations will be added to the XBML prototype. The end state for XBML will be a methodology for developing standard doctrinal terms and allowing these to be accessed as Web services. In the future Global Information Grid (GIG), each Service could have its own "BML" web service, linked to a Joint overarching BML.

Coalition partners, in particular France and the United Kingdom, are conducting similar efforts. As it is almost impossible to imagine a situation in the future when a single U.S. Service will be unilaterally employed, these efforts must be embedded into international standards. Because future military operations, and a significant amount of training, will be joint in nature, it is critical that a joint service approach be taken to the BML development effort. The same issues that have driven the Army to embark on this program also confront the other Services as they develop both their combined and joint command and control systems and simulation systems.

This led to the proposal for a study group dealing with issues of a "Coalition Battle Management Language (CBML)." CBML developed and applied by all the Services and by coalition members would not only allow interoperability among their command and control systems and simulations, but also among command and control systems themselves.

This paper will show the history and current work on BML, the international activities, a state of the art review of the three BML views, and a recommended scope for the CBML study group.

2 Current U.S. Work on BML

It goes beyond the scope of this paper to cover all preceding efforts to develop the BML concept. One critical deficiency of current simulation systems is their lack of a standardized methodology for representing command and control. Although many advanced simulation systems have excellent models and representations of command and control internal to their solution, interfaces or interoperations are hardly established. Two examples shall be referenced to: the Command and Control Simulation Interface Language (CCSIL), described in [1], and the EAGLE Combat Model Battle Management Language, presented in [2].

However, the following three interconnected but separately funded U.S. projects are setting the frame for the CBML solution: (1) the original prototype as developed for the U.S. Army, (2) the web-based prototype based on this first prototype for U.S. JFCOM (U.S. Joint Forces Command) known as XBML, and (3) the recently initiated extension of the web-based prototype for application within Air Operations.

2.1 The U.S. Army BML Prototype

The first prototype has been described in several symposia and workshops, among them the U.S. SIW [3], the European SIW [4], and the Command & Control Research & Technology Symposium (CCRTS) in [5]. For detailed information, please refer to these papers. Nonetheless, a short overview will be given in this section.

The US Army BML proof of principle comprises the following elements as shown in Figure 1:

- To generate orders, the **Combined Arms Planning and Execution System** (CAPES) is used. This is a prototype US Army Planning System. This C2 component creates operational orders (OpOrds) that are exchanged using a proprietary tagged XML document.
- A **Multi Source Data Base** (MSDB) is based on the U.S. Army Standard data model of the Joint Common Data Base (JCDB), which has been extended by the BML development team

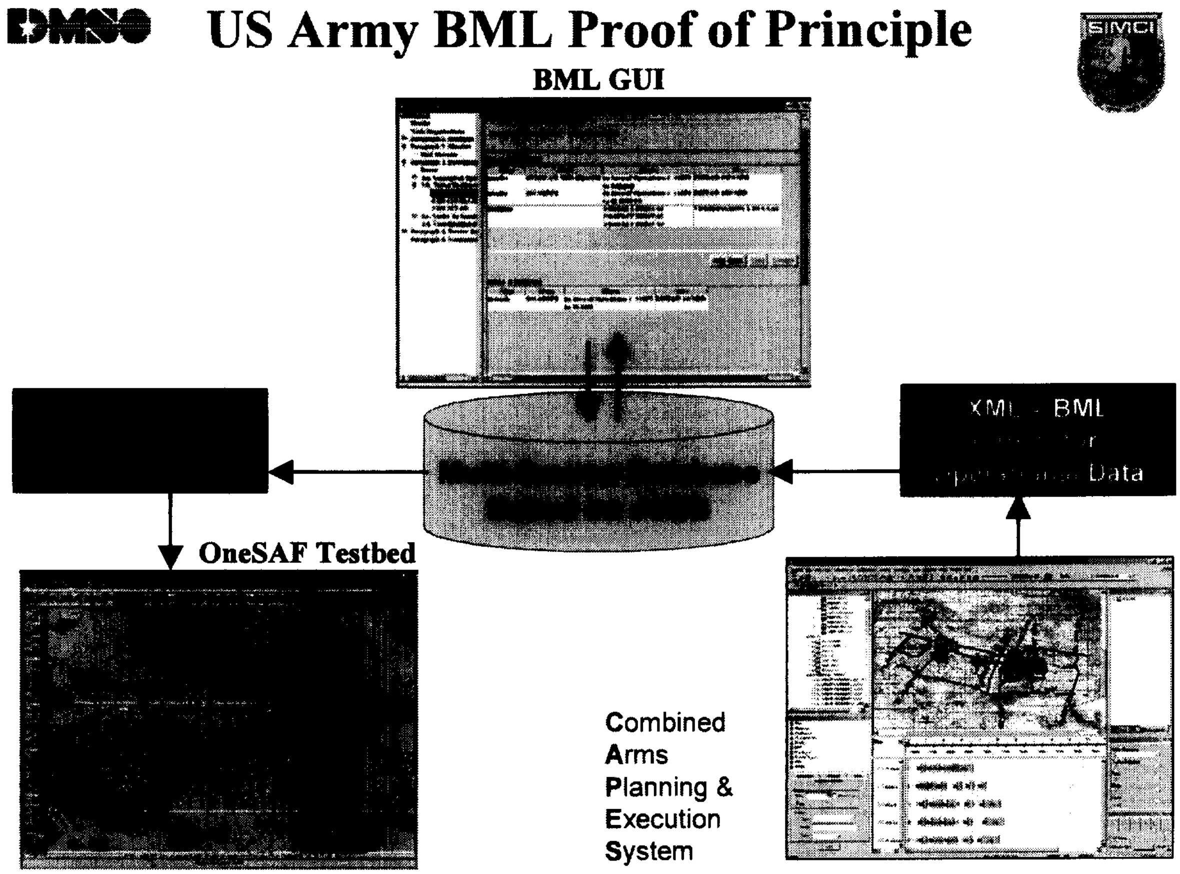

Figure 1: Components of the US Army Prototype

by introducing over 100 new tables and relations. It is accessed via standardized database manipulation statements based on ODBC or JCDB. It is implemented in open source software in the Linux environment.

- A BML demonstrator specific **XML-BML parser** reads the information from the XML document and generates data manipulation statements. The XML-BML parser reads the XML document, maps the information to data elements of the MSDB, and inserts the information contained in the document into the MSDB.
- A **BML Graphical User Interface** (BML-GUI) allows data manipulation of the content of the MSDB under consideration of the semantic and syntactic constraints of the BML. The input of CAPES can be used as a basis to create more detailed operational orders for the subordinated units (which are simulated using the OTB simulation system). The paradigm here is who-what-when-where-why, also called "the 5Ws."
- The MSDB information is based on the U.S. Army doctrinal language. In order to execute such orders, this information has to be mapped from doctrinal terms to OTB interpretable terms. This is done by the **C4I Simulation Interface** (C4ISI), which reads the MSDB and generates order files for OTB.
- Finally, the M&S component **OneSAF Test Bed** (OTB) system is used to simulate the effect of the generated orders. It reads the order generated by C4ISI and executes them.

The Army prototype demonstration focused on a real-world Army scenario – an actual National Training Center (NTC) Brigade Operations Order. The demonstration showed how a Battalion Operations Order could be built in BML and then sent to a simulation (OneSAF) to be executed.

2.2 Extensible Battle Management Language (XBML)

The U.S. Army BML Prototype proved the general feasibility of the approach. XBML was launched to raise the prototype to the new level of joint and combined operations; in other words, make it applicable to other services than the Army (joint) and other nations than the U.S. (combined). Furthermore, the integration of BML into the real future operational environment was targeted.

We designed XBML to be gradually developed and improved in phases.

- The first phase comprised two tasks: (1) a study on the applicability of joint tactical/operational data models for the MSDB, and (2) a prototypical implementation of the XMSF ideas to distribute the components of BML (CAPES, MSDB, BML/GUI, OTB) and execute them over the Web.
- The second phase is to implement and populate a C2IEDM version of the MSDB. To this end, the results of phase one, task two, are used. Furthermore, this MSDB should replace the JCDB version used before.
- The next phases are to bring additional systems in. Currently, the integration of the JSAF simulation system in addition to the OTB system is planned.

Currently, phase one has been successfully conducted and was finalized in late Spring 2004. Phase two is in the final stage; the experiences with the mapping of JCDB/BML to C2IEDM are the subject of a separate SIW paper [6]. Furthermore, the use of JSAF is under preparation. The following paragraphs will give a short overview on XBML. More details are given in [4] and [5].

XBML was supported by DMSO as part of the Extensible M&S Framework (XMSF) project. XMSF is evaluating the applicability of a set of web-based, open standards, developed by existing standards bodies, and methodologies focusing on – but not limited to – web-based distributed modeling and simulation. Because it is based on web standards, it has the ability to provide simulation services to a wide class of live systems. XMSF uses open standards and open sources to increase the efficiency of development and applicability of simulation systems. Many software systems composably scale to worldwide scope by utilizing Internet and web technologies. XMSF, by applying these web-based technologies, is an advance toward composable simulation systems. It furthermore bears the potential to migrate legacy and future M&S into web-centric components to be used in net-centric C4ISR environments, such as the Global Information Grid (GIG). These ideas are motivated and described in more detail in [7].

Various XMSF projects demonstrated the advantage of using web standards in service-oriented architectures (SOA). One of the major advantages is that the services can more easily adapt to utilize distributed applications in heterogeneous infrastructures. Nothing in particular has to be done programmatically to the service, except to enable it to receive requests and transfer results using web based messaging and transportation standards. In many cases, web services are straightforward and existing software can easily be adapted to create new web services usable within an SOA. Examples for Modelling & Simulation (M&S) applications are given in [8]. The main steps to be conducted for this purpose are

- defining the information exchanged requirements using XML,
- exchanging the information based on XML using the Simple Object Access Protocol (SOAP),
- describing the procedures, access points, ports, and data involved using the Web Service Description Language (WSDL),
- posting the WSDL schema to a universal description, discovery, and integration (UDDI) registry.

The use of WSDL and UDDI is only necessary if it is important that other services, applications, and users can search and identify the web service. Within the XBML prototype, this was not the case, as the objective was to show that BML could be web-enabled, not to establish it within a SOA (although this step is trivial after the feasibility of web-based information exchange based on XML and SOAP is demonstrated). Therefore, the first step was to cut the U.S. Army prototype into components, define the information exchange between these components using XML, to distribute the components in the web, and connect them via SOAP calls.

Figure 2 shows a schema with the resulting components and interfaces: The CAPES planning system became one component, for which the already existing XML interface could be re-used. The OneSAF Testbed simulation system became the second component. The results of the C4ISI interface was used to define the XML interface, resulting in an XML interface for OTB. The BML-GUI interface to the MSDB was the last interface. Standard tools, such as XML-Spy, creating tag sets based on the database scheme, could directly define the XML data.

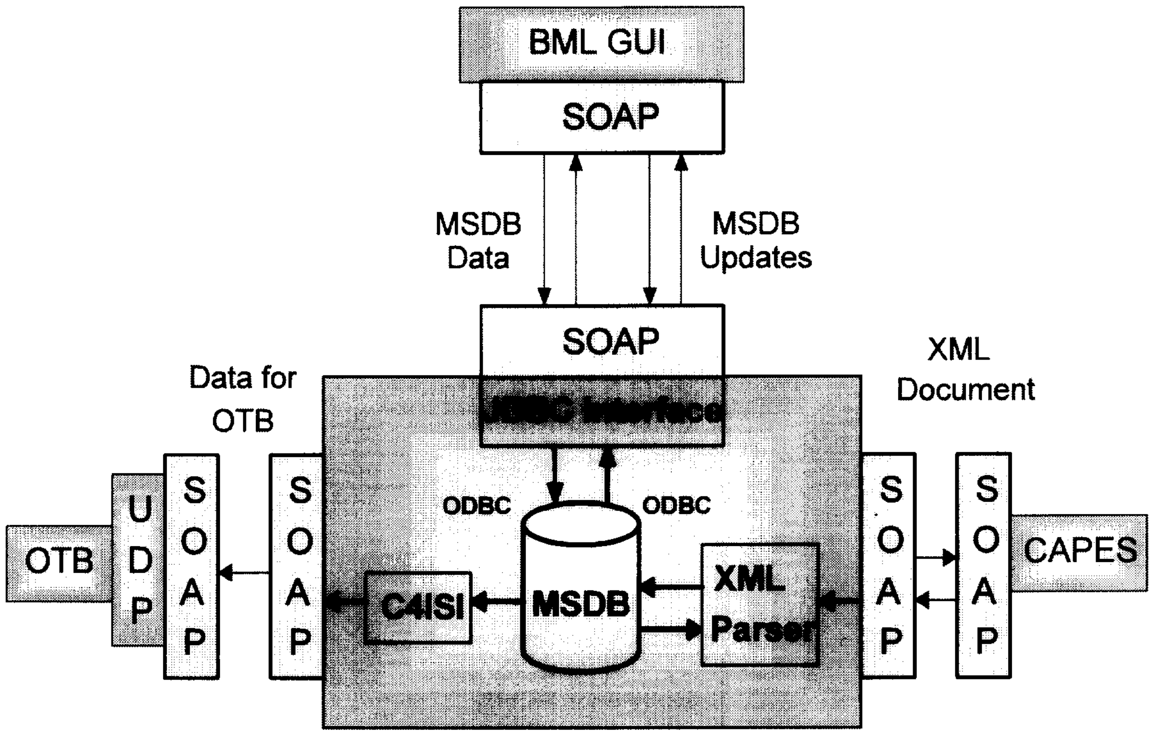

Figure 2: XBML Prototype Phase One

In parallel, the MSDB was analyzed and documented in the style of the C2IEDM, as it can be downloaded from the MIP website [9]. An overview of history and use of C2IEDM is given in [10]. The documentation comprises

- Entity definition: all entities are defined in the form of a table comprising the entity name, entity definition in text form, and attribute names (enumeration of all attributes);
- Entity relationships: every relation is defined in the form of a table comprising parent entity, a verb phrase used to describe the relation, child entity, relationship type as specified in the IDEF1X standard, the logical foreign key, the cardinality, and a value specifying if null values are allowed;
- Attribute definition: every attribute is defined in the form of a table comprising attribute name, optionality for the attribute, the entity usage, describing which entities are specified by the attribute, and the attribute definition in of text form;
- Enumerated domains: every enumerated domain (possible value for an enumeration attribute) is defined in the form of a table comprising the logical value of the enumeration, the definition of this value, and the source of the definition.

The original assumption was that this documentation could be used for direct mapping based on data engineering principles as documented in [10]. Unfortunately, this approach was not feasible. A mapping based on high-detailed descriptions of the JCDB elements was counter-productive.

The reason is explained in [10] in more detail. To summarize the main findings, it must be understood

that the "business logic" behind the data elements are the 5Ws defined earlier: WHO is doing WHAT, WHERE, WHEN, and WHY. When this BML logic was mapped to the JCDB, the business logic of JCDB had to be captured as well. Therefore, several JCDB constraints necessary for JCDB but of no value for the 5Ws description had to be taken into account. When mapping the resulting info-space to the C2IEDM, the organizational JCDB must be mapped as well. As the mapping to C2IEDM generates a similar overhead, the approach of mapping the JCDB/BML to C2IEDM was not effective, as too much JCDB overhead had to be mapped resulting in more C2IEDM overhead. The following figure shows the dilemma.

The result was to use the business logic of BML, the 5Ws, directly and map this information to C2IEDM. This process is defined in detail in [6]. It is worth mentioning that over 100 tables were added to JCDB in order to cope with the BML requirements. As stated in [6] in more detail, the mapping to C2IEDM resulted in a much smaller set of tables. The principles of direct and indirect mappings and the resulting overhead problems are illustrated in figure 3.

The mapping results were used to implement and populate a new version of the MSDB, which is now based on the C2IEDM. Principally, this database can be the source and target of information resources making use of the replication mechanisms often used in the Command and Control domain in general and in particular in the MIP. However, practically the MSDB can be the target of replications, but the business rules supported by the actual implementation do not yet ensure that all fields necessary for C2IEDM based replications will be available. In other words: it is not yet ensured that all mandatory fields for replication are set by BML applications. The general problem is described in more detail in [10].

Another ongoing activity is the establishment of XML based orders for the Joint Semi Automated Forces (JSAF) simulation system. Within another project

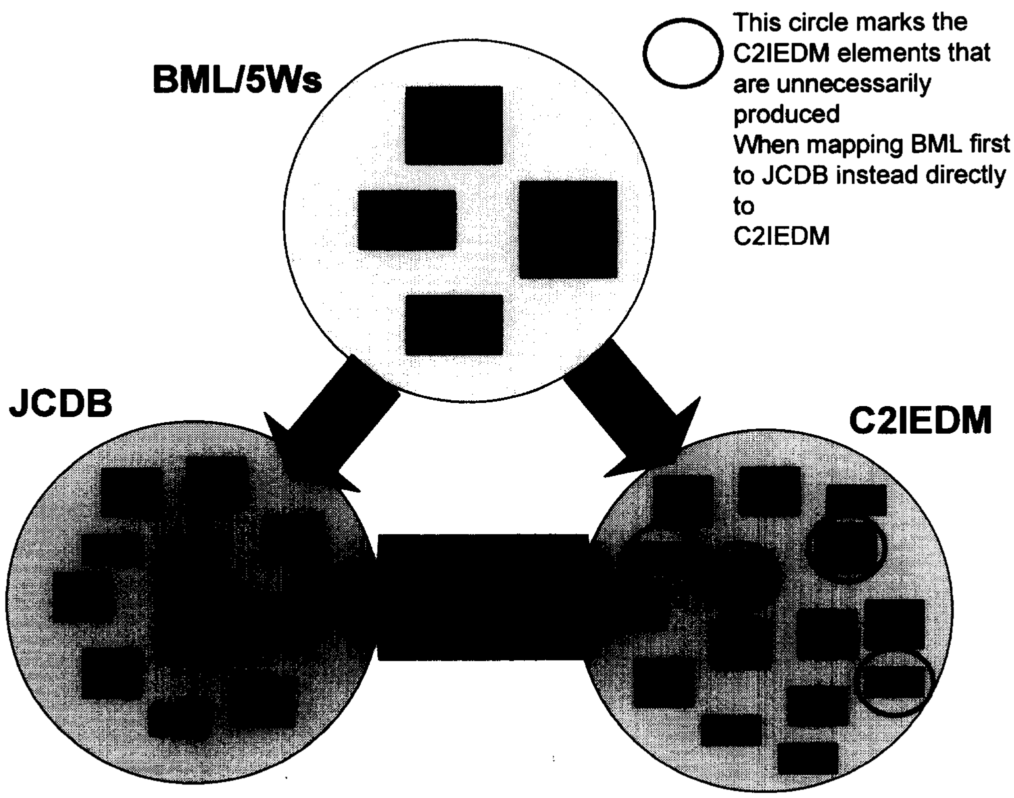

Figure 3: Indirect and Direct BML Mapping

supported by the U.S. Joint Forces Command, a web system is used to generate commands for JSAF entities. These orders are encoded using XML. This allows the mapping of such orders to the C2IEDM based tag set currently under development by the XBML team and the integration of JSAF as an additional or alternative simulation system.

In summary, the XBML project proved the feasibility and practicality of the three views of BML, as they will be described in more detail in section 4.

2.3 Air Operations Battle Management Language (AO BML)

Only recently, the XBML group was tasked to analyze the applicability of their concepts to

- efficiently deal with the information exchange requirements of Air Task Orders (ATO) and Air Coordination Orders (ACO),
- couple with a tactical U.S. Air Force system, and
- support a joint experiment in Spring 2005.

The preliminary analysis conducted so far shows that all three solutions of the XBML project can be extended and used. In particular the use of the C2IEDM as the representation of BML and the use of web services based on SOAP messages is applicable.

The AO BML will investigate how flexible the current representation is. The hypothesis is that the current "core" BML structures in the C2IEDM can be reused for AO BML, and the tasks specific to Air Operations be put in an extension set to the C2IEDM.

3 International Work related to BML

It became obvious during the recent SIWs in the U.S. and Europe that there is a strong international interest in BML and related efforts. One of the main tasks of the study group will therefore be to identify such international projects and efforts that should be taken into account to insure maximal applicability of CBML. The authors are aware of additional interests; the two programs being described here are therefore neither complete nor exclusive. These programs are leading examples and should encourage other international partners to send in descriptions of the their project, references to be analyzed, etc.

3.1 Programs in the United Kingdom

Although the Research and Development (R&D) community in the UK have long recognized the need for C4I to simulation interoperability particularly in the training domain it is now recognized that if the real benefits that will come from initiatives such as Digitization, the US Network Centric Warfare (NCW) initiative and the UK equivalent of Network Enabled Capability (NEC), then the burden of manually translating between different data protocols will need to be overcome. If not this will be the 'Achilles heel' of these initiatives because the inefficiency in communicating C2 information - between the operational systems, people involved, and simulations will fundamentally limit the benefit.

What is needed is the adoption of a common language across these functions that lends itself to both human and machine interpretation. To fulfil this need the concept of a universal BML has been introduced in the US.

3.1.1 NEC and Digitization

From the UK perspective, NEC is a vehicle to guide the coherent integration of sensor, weapon, decision-maker, and support capabilities. NEC aims to improve operational effectiveness by enabling more efficient sharing and exploitation of information within the British Armed Forces and our coalition partners. NEC is therefore key to interoperability with other nations. In particular, policy requires that the UK is able to act as an effective and capable member of future US-led coalition operations. Interoperability with the US is therefore a priority and alignment with the US Transformation process is considered essential. NEC will help the UK achieve this.

Achieving this integration and interoperability through NEC is a fundamental driver of the need for a BML. Meeting the full potential of NEC aspirations will require the co-evolution of all the Lines of Development (LoD)[1] including training. Therefore, in developing a BML, due account must be taken of its need to support interoperability across all relevant LoDs and with allies.

For the UK, the cost of replacing or updating military capability to meet the aspirations of NEC in a single jump is prohibitive. Military capability will have to evolve as a series of prioritized capabilities and a BML must similarly cope with evolution in both operational and training systems.

There is ongoing work to determine requirements for the operational employment of simulations, for example in planning and CoA, and BML will play an important role in supporting these requirements.

[1] In the UK, Lines of Development equate to US DTLOMS.

3.1.2 UK Research

During the STOW 97 programme, the UK R&D community built up considerable knowledge based on the use of CCSIL. However, subsequently there was very little development in this area until the Adaptive Middleware (AM) concept was established

More recent UK MoD Research into the impact of NEC on collective training has identified that the single most critical shortfall for current and future training is the inability to achieve flexible, adaptable interoperability with operational systems, such as future Operational Command and Information Systems (OpCIS) and ISTAR systems. Research under the Software Agents as Facilitators of Interoperability in Collective Training (SAFICT) programme identified a number of emerging technologies that could provide viable interoperability solutions. The AM concept seeks to support a run-time plug and play approach to system and organisation integration. The interoperability approach proposed by this study will significantly ease and reduce the cost of integration of future systems, enhance the flexibility of training establishments and enable the delivery of deployed collective training and mission rehearsal.

The basic concept of this work is to develop an AM solution that supports flexible plug-and-play style interoperability between SEs and C4I/ISTAR systems in the collective training environment. In contrast to conventional approaches to interoperability, which often focus primarily on data translation and exchange, the proposed work assumes that flexible system interactions can only be achieved if the middleware is viewed as a system in its own right. Its primary purpose is to support the definition and management of relationships between other systems. This approach ensures that the interoperability infrastructure is explicitly visible and manageable, and does not become a set of independent and unwieldy point-to-point inter-system connections that themselves form a significant barrier to subsequent technical change.

The proposed solution recognises that the AM must be designed to be extensible from the outset, so that a new external system can be accommodated with little or no impact on any existing combination of systems managed by the AM solution. It is also intended to support use by staff with little or no technical training. In particular, it is designed to support re-configuration within and between exercises, so that the exercise staff can provide an overall training system precisely tailored to the C4I/ISTAR training needs of different training audiences.

The work will employ a set of technologies that are entering mainstream commercial use, and which taken together offer a powerful new approach to the training interoperability problem. They provide a set of complementary mechanisms that are grounded in conventional software engineering techniques (e.g. they are based on robust mainstream programming languages), but which provide significant leverage in some key technical areas that are very relevant from an interoperability perspective.

AM should be able to support external systems (C4I/ISTAR and SEs) that exhibit a wide range of different approaches to technical interoperability, and which cannot themselves be easily modified (either because they are legacy or proprietary, or both).

The flexible adaptivity of the proposed middleware derives from two key design principles:

- Management of the data and rules that control interaction between the external elements is viewed as the primary function of the AM system;
- Encoding the data exchange rules and functions in a manner that facilitates their visualization and manipulation, for example in a relatively high level vocabulary (or ontology) that can itself be edited using tools provided by the system.

This contrasts with traditional non-adaptive data exchange solutions where the system is hard-wired around dedicated translation functions, and where the behavior of the system is encoded in low-level representations that cannot be easily inspected or modified except by skilled software engineers. Although such traditional solutions can exchange data perfectly well in closed and static environments, they constitute a significant barrier to the introduction of new external systems, especially those that exhibit novel interoperability requirements (such as emerging C4I/ISTAR systems).

To achieve flexible interoperability, such as that which is the aim of adaptive middleware, there will need to be at its logical heart some form of what might be called a reference meta-language through which 'non-standard' dialects can be mapped and made interoperable.

The meta-language within middleware will need to deal with more than operational communications such as control and data capture for analysis but otherwise there is the potential for alignment between this and the goals of BML if not BML itself.

The more that C2 and systems move towards common syntax and semantics (e.g. through a BML) the simpler the task of middleware becomes. Indeed both approaches seek to support rich interoperability.

In the UK work is now programmed to assess the US efforts on BML to see if it meets the UK requirements

for C4I to simulation interoperability. In addition the UK plan to support the CBML initiative at SISO. A more detailed discussion of the UK perspective is given in [13].

3.2 Programs in France

The French efforts in this domain have been presented in various papers during the recent SIW workshops, summarized under the acronym APLET for "Aide à la PLanification d'Engagement Tactique." APLET is a French Ministry of Defense (MoD) R&T program, which aims to investigate the capabilities offered by M&S for its integration into an existing Brigade level C4I system for Courses of Action Analysis (COAA) purposes. In addition, this program is dedicated to exploring the technical issues of C4I-M&S coupling and to providing recommendations for M&S interfaces, models, and data models to overcome the gap between current M&S and legacy C4I. A series of demonstrators are being developed to prove the feasibility and demonstrate the technical approaches studied and recommended for future use.

APLETs main objectives are to:

- automate the Military Decision-Making Process for Course of Action Analysis;
- foresee capabilities and added value given by simulation in case of close integration with C4I systems and as an example with SICF;
- explore and solve C4I-simulation inter-operability issues and propose recommendations to bridge the gap between those systems;
- define the most suitable simulation granularity allowing Courses of Action Analysis (CoAA) in a tight period and experiment new algorithms such as RDE (Reaction Diffusion Equation);
- propose mechanisms to automatically produce Operation Orders from a selected Course of Action.

The APLET schedule is divided into three phases. The first one, called "preliminary study," was aimed at addressing the gathering of operational requirements and the analysis of different technologies for C4I and simulation coupling. This phase ended with a mock-up illustrating the military requirements collected during interviews. The results were presented in [11].

The second phase goal is the development of a demonstrator for Brigade CoAA that highlights the usability and the effectiveness of the technical recommendations proposed during the preliminary study phase. This demonstrator will be tested in a real situation during a Brigade exercise in November 04. The work is summarized in [12]

The third and final phase objective is the implementation of a second version of the demonstrator, taking into account the lessons learned during experiments. Finally, the overall program will end in 2006 with the specifications for an operational system.

This program is a part of overall work on C4I-M&S interoperability led by the French MoD. A short-term objective is to obtain operational interoperability between legacy C4I and simulation systems that meets the major Military requirements. Thus, alignment of C4I and simulation data models based on C2IEDM is seen as mandatory. A mid-term objective is to share common components between C4I and M&S in order to improve interoperability and then to extend Military use of simulation on the battlefield. The long-term objective is to reach the alignment of architectures, for embedding simulation into C4I thus covering the full spectrum of operational requirements. In that frame, cooperation is envisioned within SISO C4ISR-Simulation Product Development Group (PDG) and the DMSO Program on Extended Battle Management Language (XBML).

3.3 Programs in NATO

Currently, there is no program established in NATO dealing explicitly with BML; however, BML is applicable in several domains within the alliance.

The NATO M&S Master Plan (NMSP) clearly states the necessity to couple Command and Control and simulation systems for the various objectives, in particular for training and support to operations [14]. The Pathfinder project was launched by the NMSP to prove the feasibility. The annual M&S Conference of NATO conducted last year (October 2003) in Turkey explicitly dealt with the issue of Command and Control and M&S interoperability [15]. Within the evaluation of the resulting report a closer collaboration between the NATO M&S Group and SISO is recommended.

In summary, although no explicit BML project exists in NATO, there is tremendous potential for collaboration and the study group may analyze the existing programs concerning the applicability of BML as well as additional requirements for the coalition BML work to be done.

4 BML – State of the Art

Since its first successful presentations, the community has asked for a formal specification of BML.

Although this section is far from being such a specification, it comprises references to sources for closer evaluation and ideas to be discussed within the study group in order to prepare a product in the next phase. The ideas are structured following the concepts of views introduced earlier during the XBML project phase: the doctrine view, the representation view, and the protocol view.

4.1 BML – Doctrine View

Every term used within BML must be unambiguously defined and must be rooted in doctrine. In other words, the doctrine view must be a dictionary comprising the term and its unambiguous definition as well as the source of this definition.

So far, the U.S. Army's new Field Manual 1-02 has been used to augment the term definitions of the C2IEDM definitions. In addition, the Air Tasking Order (ATO) and Air Coordination Order (ACO) as used within the U.S. are analyzed and used for new definitions. The general military dictionaries Joint Publication 1-02 and the AAP 6 contribute more terms. One idea that should be taken into consideration is the use of references to synonyms and homonyms of a term as well as a reference for languages other than English to facilitate coalition operations across language borders.

The study group should discuss these ideas, structure a dictionary based on the results, and prepare the definition to be standardized within a follow-on product development group.

The dictionary must be aligned with other SISO efforts to create a standard dictionary for use within M&S solutions (e.g., the RPR FOM definitions of the FOM/SOM lexicon) and respective command and control efforts. An additional task is therefore the identification of potential contributors.

4.2 BML – Representation View

The representation view structures and relates the terms defined in the doctrinal view in such a way that they result in the description of executable missions and tasks. A mission is thereby defined by a sequence of tasks that must be executed in an orchestrated manner. The representation must allow describing the various tasks and must also comprise the means to compose and orchestrate the task. Means to cope with causalities and temporal relationships in terms used by the warfighter belong furthermore to the requirements.

Within the XBML phase of BML, the use of the C2IEDM was evaluated, recommended, and implemented. However, as various doctrines may require tasks and missions outside the current scope of C2IEDM, extensions and enhancements must be defined and consistently applied.

The study group should analyze (a) if the C2IEDM is generally applicable to cope with these issues or if there are counter examples, and (b) what extension rules need to be captured and standardized in order to ensure consistency between separately developed extensions and enhancements.

As many organizations already using the C2IEDM, we hope that we can analyze some rules applied by them in order to find out if these rules are a good basis for standardization. In particular the MIP group is of interest, as well as the former NATO Data Administration Group. Furthermore, commercial solutions, such as data federation or data migration services may comprise valuable algorithms and rules applicable to BML challenges as well.

The representation view is academically particularly interesting and challenging. There are several expert opinions concerning the applicability of data models to cope with ontological challenges. While the authors are convinced that the use of enhanced tactical data models is feasible and should be mandatory for BML, additional ideas and future driven solutions are welcome to be discussed. One possibility is the use of AI approaches, such as the Knowledge Interpretation Format (KIF), to support the structuring process by (semi-) automatic tools. Linguistic approaches and methods used for knowledge sharing between intelligent software agents seem to be valuable.

4.3 BML – Protocol View

In order to communicate the necessary initialization data into BML and the resulting executable missions and tasks from the BML to the executing system, communication protocols are needed.

The use of XML to describe the information exchange requirements seems to be out of the question. Within XBML and the follow-on project, the use of http-based web-services was chosen. Based on first results in ongoing work of the XMSF team, as well as other interested experts in the domain of application of web services within computer grids, solutions that are more general may be needed in the international domain. Grid services are one example; although they follow the same principles for data exchange and invocation, they allow more alternatives within applicable protocols for web communication.

Based on the actual web service solution, the study group should analyze advantages and disadvantages of

alternatives and point to connected effects within the collaboration.

5 Scope of CBML

The statement of work for the CBML study group was accepted by the Standards Activity Committee and identifies the following tasks:

1. The study group shall conduct a **Paper Survey** comprising as many as possible international contributions applicable to the Coalition Battle Management Language effort. The projects and programs identified in sections 2 and 3 are a first selection of candidates.
2. The study group shall develop **a Plan** of how these various efforts identified in task one can contribute to a common CBML standard/standard framework.
3. The study group shall formulate a set of **Recommendations** on how to proceed toward a CBML product development group.

The products resulting from the establishment and execution of these tasks shall include, but one not limited to

- a literature survey summarizing the results of task one, and
- a final report, to be delivered during the SIW Fall 2005, which summarizes the results of tasks two and three.

The Command, Control, Communication, Computers, and Intelligence (C4I) forum will be leading the formation process for this study group. In addition to its SISO membership, the study group is expected to collaborate, as needed, with other organizations with potential interest in this work, in particular NATO and CCRTS groups interested in this topic.

The CBML study group formally begins work at the 2004 Fall SIW. It will submit an interim report at the 2005 Spring SIW, and will complete work and submit a final report to the EXCOM, SAC and CC by the 2005 Fall SIW. In addition to electronic collaboration facilitated by use of the SISO web site, interim meetings may be held in conjunction with other M&S-related conferences during the period of performance.

6 Summary

This paper shows the history of BML and work currently being conducted. The similarity of the actual alternatives and international contributions supports the optimistic view that a common Coalition Battle Management Language (CBML) is not only technically feasible, but can also be standardized.

The ultimate objective of this CBML study group is to prepare the way for CBML to become a SISO standard. To this end, the results of earlier and ongoing SISO activities, in particular results of the Product Development Groups for Base Object Models (BOM) and the C4ISR/Simulation Technical Reference Model (C4ISR/Sim TRM), must be evaluated and aligned. As the use of the C2IEDM for representation is a cornerstone of CBML, the alignment with the Multilateral Interoperability Program (MIP) is another mandate. However, CBML is perceived by the authors to become a milestone for C2-to-C2 as well as for C2-to-M&S interoperability, as it merges technical solutions with operational expertise by introducing doctrine as the semantic and pragmatic backbone of the technically mature web-based solution.

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Authors' Biography

ANDREAS TOLK is Senior Research Scientist at the Virginia Modeling Analysis and Simulation Center (VMASC) of the Old Dominion University (ODU) of Norfolk, Virginia. He has over 14 years of international experience in the field of Applied Military Operations Research and Modeling and Simulation of and for Command and Control Systems. In addition to his research work, he gives lectures in the Modeling and Simulation program of ODU. His domain of expertise is the integration of M&S functionality into real world applications based on open standards.

MICHAEL HIEB is an Assistant Vice President for C4I Programs for Alion Science and Technology. Dr. Hieb is currently an Architect for the Army SIMCI OIPT. He received his Ph.D. in Information Technology at George Mason University in 1996 and performed his doctoral research at the GMU Center for Excellence in C3I. Dr. Hieb received his MS degree in Engineering Management from George Washington University and his BS degree in Nuclear Engineering from the University of California in Santa Barbara. He has published over 50 papers in the areas of M&S integration with C4I and Machine Learning. Previously, he worked as a Nuclear Engineer for General Electric.

MAJOR KEVIN GALVIN is a serving Infantry officer with over 30 years of service in the British Army. In the last 9 years, he has been actively involved in the UK Digitization programme as an Operational Architect looking at Command and Control processes and information flows. He is currently the military SME in support of the research programme looking at combat readiness on behalf of the Directorate of Equipment Capability (Ground Manoeuvre) but working with QinetiQ. He received his MSc degree in Defence Modelling and Simulation from Cranfield University at the UK Defence Academy. His BSocSc in Economic and Social History was from Birmingham University. He has collaborated on a number of papers at the Command and Control Research and Technology Symposium.

LIONEL KHIMECHE is a R&T program manager in the field of M&S for forces readiness (ESTHER), support to operation (APLET) and C4I-Simulation Interoperability (CALIPSO) at the French MoD (DGA/SPOTI Délégation Générale de l'Armement / Service des Programmes d'Information, de Télécommunications et d'Observation). Within NATO, he is the MSG-002 "M&S Support from PATHFINDER Programs to bi-SC Staff Training and Exercises Capabilities," Co-Chairman. In addition, he has international responsibilities as French Technical Project Officer for the DEA1188 dealing with Training Devices and Simulation Technology and French chairman for the simulation group of the French-German Electronic Commission.